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Subsidence of the West Siberian Basin: Geophysical evidence for eclogitization

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The West Siberian basin is the world's largest intracratonic sedimentary basin. The basin basement consists of complexes of island arcs, terranes, micro-continents, and relict ocean basins which amalgamated during late Proterozoic-Paleozoic orogenic events up to the formation of the Pangea super-continent. The basin was affected by rifting and flood basalt eruption in the Permian-early Triassic (ca 250 Ma), which was floowed by rapid late Triassic (190 Ma) subsidence, as observed in borehole data from the axial part of the Ob rift (Saunders, 2005). Widely distributed subsidence of the north and central parts of the basin took place in the Jurassic with accumulation of 1,5- 3 km sediments. Two other subsidence episodes in the early Cretaceous and in the Late Cretaceous to Cenozoic led to deposition of 2-3 km of sediment in the north-eastern and axial parts. (Rudkevich, 1976).
Most of the present-day West Siberian basin lacks surface topography, whereas the reliefs of the Moho and the top of the basement have amplitudes of ca. 20 km and 15 km, respectively (Cherepanova et al., 2012). Modeling suggests that the thermal lithosphere is 130km thick in the West Siberian basin, up-to 260 km in the Siberian craton further east, and 90 km in the axial part of the basin under the Ob rift (Artemieva and Mooney, 2001).
Assuming local isostatic equilibrium and no effect of dynamic topography (which probably is a valid approximation for most of the region, except for the southern margin and the Urals), we examine the relative contributions of the crust and the lithospheric mantle to maintaining the surface topography. Lithosphere buoyancy is controlled by thicknesses and densities of the crust and the lithospheric mantle, and therefore by composition, metamorphic state, and temperature. Crustal thickness and density are constrained by our new regional crustal model, which is based on a quality-controlled compilation of all seismic models published in international and Russian literature, theses and reports since the 1970s (Cherepanova et al., 2012). Lithosphere thickness and temperature (which are interrelated parameters) are constrained by the thermal model. Our results indicate the presence of a large high-density anomaly in the upper mantle below the axial part of the basin. This result is supported by the seismic velocity variation in the mantle along two ultra-deep Soviet PNE reflection/refraction profiles and with the regional subsidence history and stretching factors. We suggest that this density anomaly is caused by eclogitization, and that the density increase from this process may explain a substantial part of the subsidence of the West Siberian Basin.